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Handover between different access networks

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ABSTRACT

The present invention relates to mobile access to telecommunication networks, such as the Internet. The invention deals with the situation where a physical interface is used to connect to an access network, and, in particular, the handover of an existing connection from one physical interface to another between different access networks.

The invention provides a logical interface, which serves to assign IP address(es) to a communication between a mobile node and a physical interface layer. The assigned IP address(es) are presented to the above mobile IP functionality layer and thus, in effect, the application.

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Invention Title: HANDOVER BETWEEN DIFFERENT ACCESS NETWORKS

The following statement is a full description of this invention, including the best method of performing it known to :- us

HANDOVER BETWEEN DIFFERENT ACCESS NETWORKS

FIELD OF INVENTION

The present invention relates to mobile access to telecommunication networks, such as the Internet. The invention deals with the situation where a physical interface is used to connect to an access network, and, in particular, the handover of an existing connection from one physical interface to another between different access networks.

BACKGROUND ART

With the growing use of both portable devices, such as computers and the use of the Internet, there is a growing need for users to remain connected to the Internet regardless of their physical position or location.

Internet Protocol Version 4, IPv4, attempted to set a standard directed to enable telecommunication providers and designers to address the demand for mobility, such as having mobile hosts through the IETF Working Group's scheme involving the use of "home agents" and "foreign agents". With routing based on the subnet prefix in a packet's destination IP address, packets destined for a mobile node (host or router) are able to reach it while the mobile node is away from its home link (the link on which its home IP subnet prefix is in use). Nonetheless, many problems still remained.

The design of Mobile IP support in IPv6 represented a combination of experience gained from the development of Mobile IP support in IPv4, together with opportunities provided by the design and deployment of a new version of IP itself as well as some new protocol features (offered by IPv6). Mobile IPv6 thus shares many features with Mobile IPv4, but the protocol is also integrated into IP and provides many improvements over Mobile IPv4.

Mobility support in IPv6 is particularly important, as mobile hosts are likely to account for a majority or at least a substantial fraction of the population of the Internet during the lifetime of IPv6. IPv6 is a standard, which outlines requirements for mobility support, however it doesn't provide any specific implementation for Internet mobility.

Mobile IPv6 outlines that a mobile node may move from one link to another without changing its IP address. A mobile node is always addressable by its "home address", an IP address assigned to the mobile node within its home subnet prefix on its home link. While situated away from its home, a mobile node is also associated with a care-of address, which provides information about the mobile node's current location. Packets addressed to the mobile node's home address are transparently routed to its care-of address. Hence packets may be routed to the mobile node using the home address regardless of the mobile node's current point of attachment to the Internet, and the mobile node may continue to communicate with other nodes (stationary or mobile) after moving to a new link. The association of the home address of a mobile node with a care-of address for that mobile node, along with the remaining lifetime of that association is called a "binding".

A movement detection mechanism in Mobile IPv6 provides bidirectional confirmation of a mobile node's ability to communicate with its default router in its current location (packets that the router sends are reaching the mobile node, and packets that the mobile node sends are reaching the router). This confirmation provides a detection of the "black hole" situation that may exist in some wireless environments. This is where the link to the router is asymmetric (that is, it does not work equally well in both directions) such as when the mobile node has moved out of good wireless transmission range from the router. The mobile node may then attempt to find a new router and begin using a new care-of address if its link to its current router is not working well. In contrast, in Mobile IPv4, only the forward direction (packets from the router are reaching the mobile node) is confirmed, allowing the black hole condition to persist.

In Ipv6, while a mobile node is away from home, its home agent intercepts any packets for the mobile node that arrive at the home network, using IPv6 Neighbour Discovery rather than ARP (Address Resolution Protocol) as is used in Mobile IPv4. The use of Neighbour Discovery improves the robustness of the protocol (eg, due to the Neighbour Advertisement "override" bit) and simplifies

implementation of Mobile IP due to the lack of concern with any particular link layer as is required in ARP.

The mobile IPv6 protocol is also suitable for mobility across homogeneous media as well as for mobility across heterogeneous media. For example, Mobile IPv6 facilitates node movement from one Ethernet segment to another as well as it facilitates node movement from an Ethernet segment to a wireless LAN cell, with the mobile node's IP address remaining unchanged in spite of such movement.

As such, the Mobile IPv6 protocol addresses the "macro" mobility management problem posed by an evolving Internet, however, it does not address the "micro" mobility management applications, for example, handoff among wireless transceivers each of which covers only a very small geographic area. In many current wireless LAN products, Link-layer mobility mechanisms allow a "handoff" of a mobile node from one cell to another, re-establishing Link-layer connectivity to the node in each new location. As long as such handoff occurs only within cells of the mobile node's home link, such Link–layer mobility mechanisms are likely to offer faster convergence and lower overhead than Mobile IPv6.

Mobile IPv6 is considered to address the problem of transparently routing packets to and from mobile nodes while away from home. However, it is considered not to address many problems related to the use of mobile nodes or wireless networks. In particular:

- Handling links with partial reachability, such as typical wireless networks. Some aspects of this problem are addressed by the movement detection procedure of Mobile IPv6, but no attempt has been made to fully address this problem in its general form. Implementations to address most aspects of this problem have been attempted by restricting networks to only one router per link, although there is considered to be problems when two nodes on the same link (on opposite sides of the router) attempt to communicate directly.

- Access control on a link being visited by a mobile node. This is a general problem any time an untrusted node is allowed to connect to any link layer. It is independent of whether the connecting node uses Mobile IP, DHCP, or just "borrows" an IP address on the link.

The movement of a mobile node away from its home link is transparent to transport and higher layer protocols and applications. However, this movement is not transparent to the lower physical and media access or data link layers.

The Mobile IPv6 protocol provides many improvements for mobile Internet communications. However, it is clear that a Mobile Node (MN) accessing the Internet using one physical interface connected to an access network, cannot change connection point to go through another physical interface (connected to some other access network) without losing all existing connections. To explain this figure 1, shows an existing connection for a communication between a mobile node running an application (10) and a physical interface (IF1). A mobile node has an existing communication (connection 1), transported by the Mobile IPv6 functionality (MIP) in the mobile IP layer, with an access network (access network 1) via a first physical interface (IF 1). A second access network (access network 2) can only be accessed via a corresponding second physical interface (IF 2). To achieve this, connection 1 must be terminated and a new connection, (connection2) corresponding to the new route via the second physical interface (IF2) is established. The reason for this is that Mobile IPv6 can accommodate a change in the network behind one physical interface, but not behind two or more as the socket opened by the application is connected to one, and only one, address assigned to an interface.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a way of addressing the mobility problems associated with the mobility protocols, such as Ipv4 and Ipv6.

In one aspect the present invention provides in a communication system including

a first access network having a first physical interface operatively residing in a physical interface layer for accessing the first access network,

a second access network having a second physical interface operatively residing in the physical interface layer for accessing the second access network, and

a mobile IP layer supporting mobile IP functionality and for establishing a communication between at least one mobile node and the physical interface layer, an improvement including

a logical interface interposed the mobile IP layer and the physical interface layer wherein the logical interface serves to assign an IP address to the communication between the at least one mobile node and the physical interface layer, the assigned IP address corresponding to

(a) the first physical interface;

(b) the second physical interface, or

(c) the first and second physical interfaces.

Preferably the communication is handed over from the first access network to the at least one other access network via the at least one other physical interface.

Preferably the mobile IP functionality layer is notified of the assignment of an IP address.

Preferably the IP address is assigned on the basis of a change in the IP address on or at the first physical interface or a change from the first physical interface to the second physical interface.

In another aspect the present invention provides an improvement wherein the logical interface maintains a single service access point for an application of the at least one mobile node.

In still another aspect, the present invention provides a method of assigning an IP address from a first physical interface to a second physical interface,

The first and second interfaces being in a communication system including a first access network having the first physical interface operatively residing in a physical interface layer for accessing the first access network, and including a second access network having the second physical interface operatively residing

in the physical interface layer for accessing the second access network, the communication system also including a mobile IP layer supporting mobile IP functionality and for establishing a communication between at least one mobile node and the physical interface layer, the method including the steps of:

providing a logical interface interposed the mobile IP layer and the physical interface layer, and;

assigning an IP address to the communication between the at least one mobile node and the physical interface layer, the assigned IP address corresponding to

(a) the first physical interface;

(b) the second physical interface, or;

(c) the first and second physical interfaces.

Preferably, the IP address assigned serves to route the communication to the first and/or the second physical interfaces.

Preferably, the IP address is assigned on the basis of a change in the IP address on or at the first physical interface or a change from the first physical interface to the second physical interface.

In another aspect, the present invention provides a method wherein the logical interface maintains a single service access point for an application of the at least one mobile node whereby the communication between the at least one mobile node and the physical interface layer remains active while allowing a change of physical interface.

In essence, the invention stems from the need to route an existing connection through more than one physical interface or a change in a physical interface. This is achieved by providing what is referred to as a logical interface, and which serves to assign IP address(es) to a communication between a mobile node and a physical interface layer. The assigned IP address(es) are presented to the above mobile IP functionality layer and thus, in effect, the application. A change in IP address corresponds to a change in physical interface, which in turn provides a choice of access network. In other words, the logical interface routes

the communication between an application and interface from one interface to another interface by assigning an appropriate IP address.

The invention stems from the realisation that the mobile IP functionality layer is capable of handling a change in the IP address assigned to a physical interface. It hides the change from the application level so that applications can keep all existing connections alive or active. However, the mobile IP functionality layer cannot handle a change of the actual physical interface. This can be accomplished using the "logical" interface between the mobile IP functionality layer and the physical interface layer. The logical interface acts as a buffer between the mobile IP functionality layer and the physical interface layer where changes in the physical interface occur. The primary function of the logical interface is to maintain the single service access point for the application while allowing a change of physical interface. The IP address assigned to the logical interface depends on the physical interface used. The IP address of the logical interface changes either because the IP address associated with the used physical interface changes or the used physical interface itself is changed

The invention allows for load sharing between different interfaces without the application knowing about it. The invention also allows seamless handover between interfaces and soft handover can be implemented using two physical interfaces simultaneously. That is, packets are communicated simultaneously from two different physical interfaces for some period of time. With this solution, packet loss can be minimized. Soft handover requires some support from the network side.

Importantly, a practical application of the present invention allows for connection handling between different access networks so that a user can maintain existing connections.for a network connection to be handed over to the most appropriate access network, for example from a mobile UMTS network to a WLAN and visa versa. The invention allows the change in physical interface (and also in access network type, e.g. from UMTS network to WLAN network) without either the mobile IP layer or the application noticing it. The access network may also be GSM, Bluetooth or other form of media.

Preferred embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a schematic diagram of a prior art system showing a connection of a mobile node to a communication system through a single physical interface.

Figure 2 is a schematic diagram of a communication system including an embodiment of the present invention showing the logical interface of the present invention facilitating the handover of an existing connection from one access network to another.

With reference to figure 2, a number of communication paths are illustrated. Path 1 illustrates a mobile node (MN) using interface 1 with IPv6 address 1 (if1, ip1). If interface 2 (if2) is to be activated, then a new IP address (ip2) is assigned to interface 2 as represented by path 2. The logical interface is notified or "told" that physical interface (if2) is now used. The logical interface's IP-address is changed accordingly, as represented by path 3. The mobile IP layer is informed about the change in IP address. The mobile IP layer is not aware of the change in interface. The invention uses a feature of the protocol in which the application can handle change of address (as illustrated by path 3), and the logical interface of this invention handles the 'physical' change of network associated with the interface change from ip1 to ip2.

The invention may also activate one or more interfaces simultaneously using the present invention by virtue of the logical interface 'notifying' which selected interface(s) from all possible interfaces is/are to be used.

The mobile IP layer sends a Binding Update as represented by path 4 to the mobile node's (MN) Home Agent (HA). The home agent (HA) can be in any practical location, such as somewhere in the communication system contactable via the Internet, depending on the home network location. The Binding Update is also sent to any Correspondent Node (CN) as illustrated by path 5 if an open connection exists between the mobile node (MN) and correspondent node (CN).

All packets from this point forward are handled by the Mobile IPv6 functionality in the mobile IP layer. In each subsequent packet the source address is set to current address and the Home Address option field is added.

Packets are then sent to the logical interface, which routes them to the currently active interface (if2) or selected interfaces.

Load sharing between two or more physical interfaces is thus possible by virtue of the present invention. If Mobile IPv6 is not implemented, load sharing can be done on a connection by connection basis which is not as efficient as that outlined above under use of the present invention. That is, the IP address behind one opened connection cannot change without losing the connection. If Mobile IPv6 is enabled, the current physical interface can be changed during a connection.

Advantgeously, the present invention allows load sharing between different interfaces, in effect without the application knowing about this, the invention allows relatively seamless handover between interfaces, and / or the invention allows a relatively soft handover implementation using simultaneously two physical interfaces, thus resulting in little, if any, packet loss.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. In a communication system including

a first access network having a first physical interface operatively residing in a physical interface layer for accessing the first access network,

a second access network having a second physical interface operatively residing in the physical interface layer for accessing the second access network,

a mobile IP layer supporting mobile IP functionality and for establishing a communication between at least one mobile node and the physical interface layer an improvement including

a logical interface interposed the mobile IP layer and the physical interface layer wherein the logical interface serves to assign an IP address to the communication between the at least one mobile node and the physical interface layer, the assigned IP address corresponding to

(a) the first physical interface;

(b) the second physical interface, or;

(c) the first and second physical interfaces.

2. An improvement as claimed in claim 1, wherein the communication is handed over from the first access network to the at least one other access network via the at least one other physical interface.

3. An improvement as claimed in claim 1 or 2, wherein the mobile IP functionality layer is notified of the assignment of an IP address.

4. An improvement as claimed in claim 1, 2 or 3, wherein the IP address is assigned on the basis of a change in the IP address on or at the first physical interface or a change from the first physical interface to the second physical interface.

5. An improvement as claimed in claim 4, wherein the logical interface maintains a single service access point for an application of the at least one mobile node.

6. A method of assigning an IP address from a first physical interface to a second physical interface in a communication system including a first access network having a first physical interface operatively residing in a physical interface layer for accessing the first access network, and including a second access network having a second physical interface operatively residing in the physical interface layer for accessing the second access network, the communication system also including a mobile IP layer supporting mobile IP functionality and for establishing a communication between at least one mobile node and the physical interface layer,

the method including

providing a logical interface interposed the mobile IP layer and the physical interface layer, and;

assigning an IP address to the communication between the at least one mobile node and the physical interface layer, the assigned IP address corresponding to

(a) the first physical interface;

(b) the second physical interface, or;

(c) the first and second physical interfaces.

7. A method as claimed in claim 6, wherein the IP address assigned serves to route the communication to the first and/or the second physical interfaces.

8. A method as claimed in claim 6 or 7, wherein the IP address is assigned on the basis of a change in the IP address on or at the first physical interface or a change from the first physical interface to the second physical interface.

9. A method as claimed in claim 8, wherein the logical interface maintains a single service access point for an application of the at least one mobile node whereby the communication between the at least one mobile node and the physical interface layer remains active while allowing a change of physical interface.

10. A method of handing over an active communication session in a telecommunication network, the method including assigning IP addresses as claimed in claim 6 corresponding to step (c).

DATED THIS 3rd day of April 2001

TELEFONAKTIEBOLAGET LM ERICSSON (publ)

RCS/SH

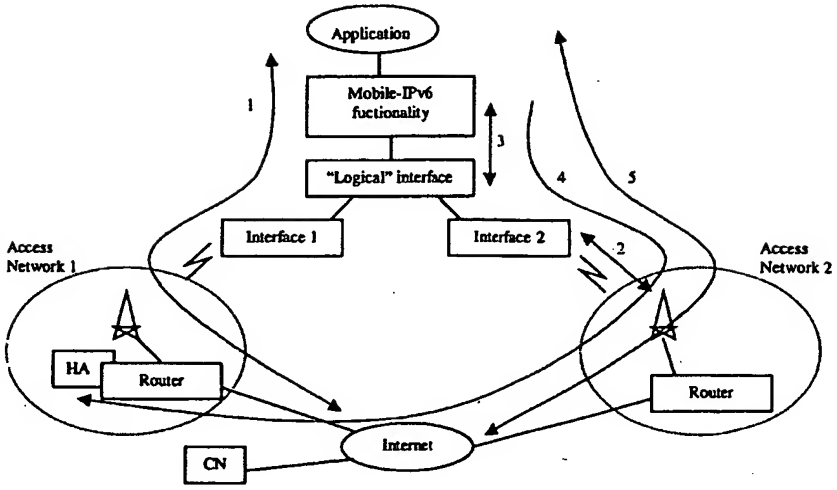

Figure 2

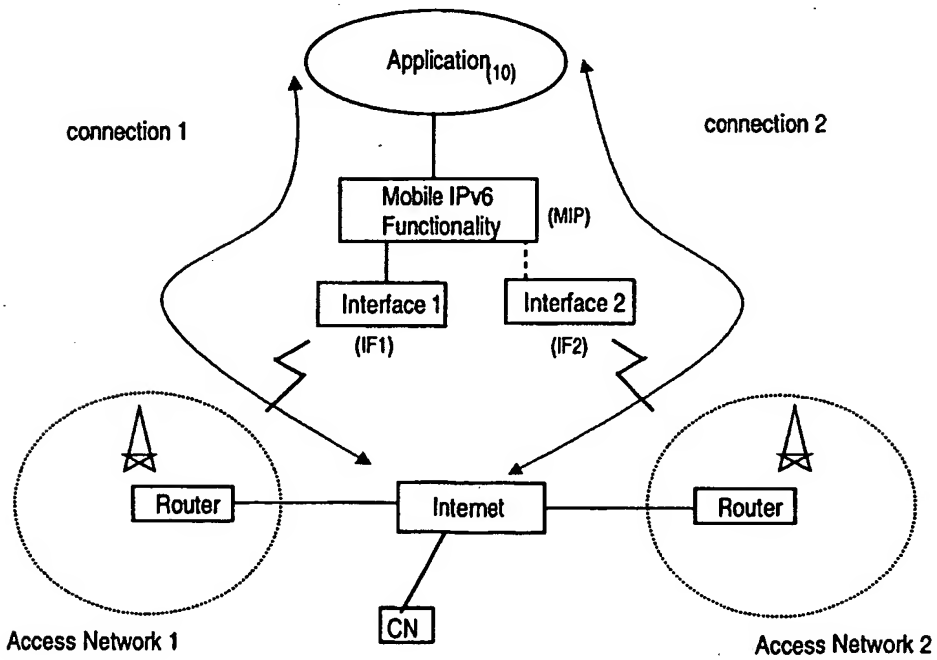

Figure 1